Funding Models for SDI Implementation: from Local to Global

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Introduction

Spatial Information is seen as a key driver in the transition of the world economies from manufacturing economies to more Knowledge-based economies (Andari Consultants, 2001). This is so because associated with this transition are an increasing number of diverse products and services that rely on, or use spatial information to achieve their objectives. This significant role of spatial information to today's society is further emphasized by The Clinton Executive Order 12906, which states, " *Geographic Information is critical to promote economic development, improve our stewardship of natural resources and protect the environment.…"*

In order to support and improve on the usage/application of spatial information there need to be in place adequate Spatial Data Infrastructures (SDI) right across the spectrum of today's information society. These SDIs will be used to facilitate and improve on access, dissemination and sharing of spatial information so that the information society can better reap the expected social and economic benefits to be derived from the application of spatial information.

The information Society especially the SDI/GIS communities are well aware of the above facts and have taken a number of steps (research, publications, conferences, workshops and SDI implementations) to ensure that there is and will be adequate access/supply of spatial data/information. This awareness can be measured in terms of the number of SDI initiatives in place through out the information society (see http://www.spatial.maine.edu/~onsrud/GSDI.htm) all aimed at improving the quality and availability of spatial information. These SDIs and their components vary from local SDIs to a global SDI (fig. 1) (see also Rajabifard, 2002).

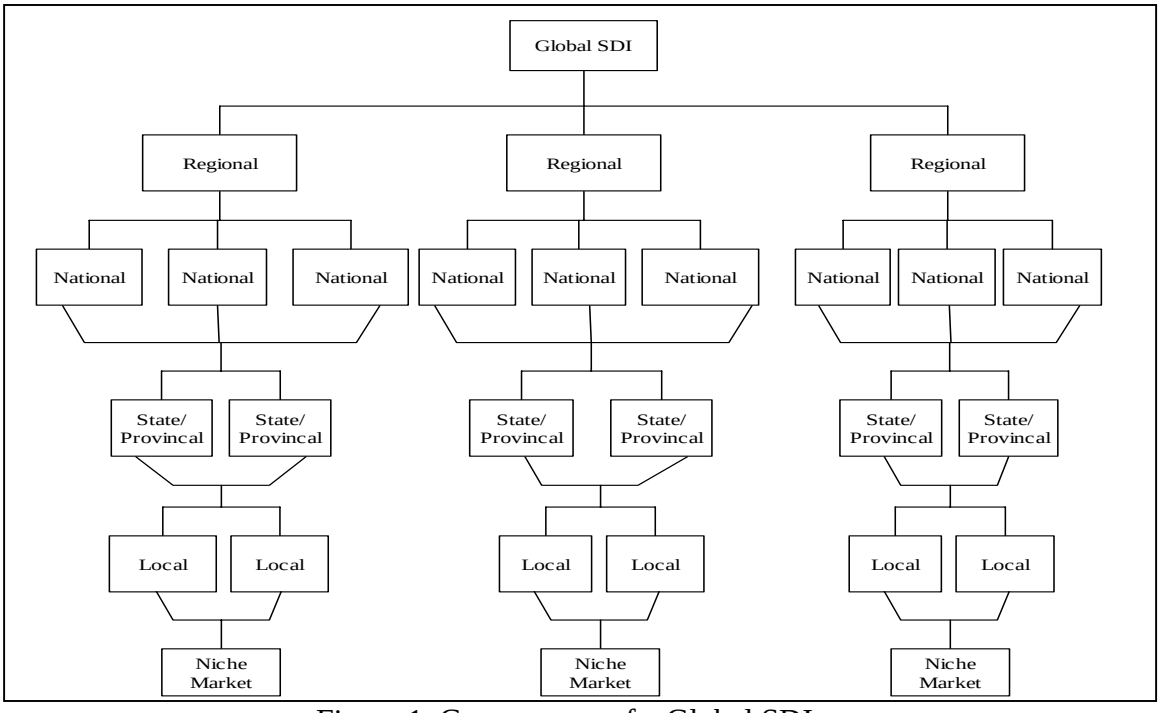

Figure 1. Components of a Global SDI

However, although significant work has been done (and in progress) on SDI implementation, which the SDI community must be commended on, research revealed significant deficiencies in the area of the funding of SDI implementation. This result is also confirmed by other authors example (Groot, 2001), (Rhind, 2000) (Rhind, 1999) and (Beerens and de Vries, 2001).

This paper is the result of research carried out at the University of New Brunswick to address these deficiencies particularly that of financing the implementation. The paper does not intend to propose funding models for individual SDIs but instead to provide and review conceptual models for the financing of the different levels/components of a SDI as defined by Rajabifard 2002. The intent of this paper is to attract the interest (input) of the more experienced SDI managers and stimulate additional research in this area of SDI implementation.

Spatial Data Infrastructure (SDI)

The term Spatial Data Infrastructure (SDI) refers to the integration of a number of components to create an environment which enables a wide variety of users to economically access precise, standardize and complete spatial information in the format that they require. The exact definition of a SDI varies from country to country however, the four main components common to most definitions are:

1. The Fundamental datasets;
2. Standards;
3. The Technology (for access, storage, format, analysis and dissemination) and;
4. The Institutional framework (necessary for the coordination of the efficient integration of the components).

The above components along with others are integrated to build an infrastructure upon which a variety of government, quasi-government, private sector, national security, environmental and community activities can take place. That is, a SDI will be used by a wide cross-section of the society to access and or distribute spatial information. Therefore, in order to satisfy the demands of the different levels of the society a SDI must be developed to provide spatial information for all levels.

Hierarchy of a SDI

Similar to other infrastructures a SDI may be viewed as having different levels. These levels normally form a hierarchy based on administrative and or political boundaries (Rajabifard, 2002). This hierarchy as defined by Rajabifard, 2002 ranged from a global level to a corporate level (figure1) with the responsibility for the implementation of each level varying from the governments of the administrative boundaries to a combination of private sector and different aspects of the public sector. The questions to be answered here when designing funding models are:

- Are there different implementation strategies for the different levels of a SDI or are they just subsets or smaller versions of the global implementation strategy? and;
- How does the answer to the above questions affect the funding policies?

It is fundamental to understand the concept of a SDI, the inter-relationship of its components and the implementation environment before attempting to structure the economic issues associated with SDI implementation.

The Economic Issues of SDI Implementation

The economic issues involved in the implementation of a SDI are covered by both strategic and operational management principles. The issues related to strategic management are the more complex and interesting of the two. Some of the more challenging management issues that must be addressed by SDI program managers are:

- The economic viability of a SDI (Benefit Cost Analysis);
- Strategic Planning
    - Funding Models
    - Pricing Policies
    - The role of a SDI in the global market; and
- The economic issues associated with day to day operations.

The first phase of implementing a SDI involves the determination of whether or not the SDI is economically viable. This is usually achieved through a benefit cost analysis and is the economic issue of SDIs that has been explored most (Rhind, 1999). A number of researches have been carried out in this area to determine the value of SDIs and GISs (NASA, 1995; Korte, 1996; Silva, 1998). However, researchers in general are still ignoring the next phase of the implementation (i.e. strategic planning) especially the funding aspect of this phase (Groot, 2001) (Rhind, 1999). Researchers/ SDI program managers have yet to comprehensively investigate and structure the problems associated with financing the implementation of a SDI. Research revealed that the first generations of SDIs were mainly financed in an ad hoc manner with no structured funding models for their implementation (Giff, 2000). If the SDI community intends to improve on the implementation mechanism of the second generation of SDIs then, some of the more pertinent questions they need to answer urgently relating to the economic issue of SDI implementation are:

- Are there current funding models in place for SDI implementation?
- Can the current models (if they exist) finance the next generation of SDIs?
- Does each level/component of a SDI require a different funding model for its implementation?
- Are funding models for SDI implementation in developed world applicable in emerging nations? and
- If they are applicable, what kind of modification will be required of these models?

This paper will attempt to answer some of the above questions and present facts to the readers relevant to the remaining questions thus, allowing the readers the option of drawing their own conclusion.

Funding Models for SDI Implementation

If we are to proceed on the tenet that a SDI is an essential part of a nation's capital infrastructure providing a basis for economic, social and environmental development, then there should be in place funding models for SDIs just as how funding models exist for other capital infrastructure development.

The Concept of SDI Funding Models

The main purpose of a SDI funding model is to act as a guideline for SDI program managers on how to formalize and source financing for the implementation and maintenance of a SDI. Funding models are not universal since; the implementation environment of individual SDI may differ thus, requiring adjustment to the models. However, conceptual funding models can become very important to SDI development since, they can provide SDI program manager with answers to such questions as:

- Where and how to seek out funds?
- Over what period will the funds be disbursed? and
- What are the effects of funding on pricing policies?

The answers to the above questions are even more significant to emerging nations and nations in transition. This is true since, these nations are usually influenced by the negative effects of having very limited financial resources, poor capital markets and inadequate political structures (IIPF, 2001). These and other factors will make infrastructure financing which on its own is a formidable task an even more complex problem. Therefore, long term capital financing models for SDI implementation as the potential of becoming an important tool for assisting SDI program managers of these nations in sourcing, structuring and formalizing funding for SDI implementation.

Funding of the First Generation of SDIs

The majority of today's existing SDIs evolved from National Mapping Agencies. Thus, a significant proportion of their funding was derived from the budgets of national mapping agencies. Therefore, the first generation of SDIs had similar funding structures to that of their national mapping agencies. That is, they were mostly a combination of Government Funding (derived from taxation and external funds), special project funds and to a lesser extent Private/Public Sector Funding (derived from fees charged to customers) (Rhind, 2000). Funding of the early SDIs were done in a piece meal manner as they evolved with not much consideration for future funding. However, if next generations of SDIs are to be successful then there must be in place properly structured funding mechanism for their implementation and maintenance.

The next generation of SDIs will also be affected by the universal changes adopted by governments through today's society. That is, governments are implementing measures to reduce their financial responsibility towards infrastructure development.

With this in mind and the changing nature (maturity) of the next generation of SDIs, it can be concluded that SDI program managers will have to develop alternative funding models and or persuasive arguments for the maintenance of government financing for SDI implementation.

Funding Models for National Level SDIs

A SDI at the National level is very important to a nation's development and requires a strong political will and contributions from all sector of the society for its successful implementation. Another key success factor to SDI implementation at this level is well-designed funding models.

There are a number of methodologies that can be used to design funding models for SDI implementation at the national level. These methodologies will differ based on the different issues associated with the implementation environment (Giff and Coleman, 2002). This paper opted to go with the view that a SDI is a provider of public good with positive externalities and thus, selected this issue as the key designing factor (Giff and Coleman 2001 and Martinez and Frank, 2001). This selection is justified since, at the national level the main function of a SDI is to satisfy national needs (Rhind, 2001). That is, providing spatial information to support: the modernization of the public sector, e-government, e-commerce, defense, emergency, and environmental and social activities.

An SDI may be viewed as a Classic Infrastructure providing public goods since, spatial information displays a majority of the characteristics associated with public goods (Giff, 2001 and Martinez and Frank, 2001). There are two main economic theories (problems) associated with public goods that are significant to the designing of the funding models. They are:

- The production of public goods normally results in market failures and
- The creation of natural monopolies (Economides, 1993,1996, Yevdokimov, 2000, Giff and Coleman, 2001 and Martinez and Frank, 2001).

The above problems are significant in the design of the models since they require government intervention to successfully correct them (Economides, 1993). Therefore, government policies will play a key role in the designing of the models.

If an SDI is viewed as a Classic Infrastructure/ Natural Monopoly producing public goods then it's the duty of the government to intervene and correct the economic problems associated with this type of infrastructure. There are four main remedies available to governments to reduce or eliminate the negative effects of market failure and natural monopolies on the society. They are:

- Economic Regulation;
- Monetary incentives or deterrents;
- Seeking compensation in the courts; and
- Government provision of the goods and services (Fraser et al, 2000)

Government's role in SDI development at the national level is further emphasize by private sector demands on them to improve access to spatial data so that more business opportunities/commercial activities can be generated. This implies that government has a

very significant role to play in the economic development of a SDI and thus, their function must be considered in the design of the models.

In designing the models the remedies of economic regulation and the provision of the goods and services by government played a significant role. However, consideration was also given to the fact that governments through out the information society are cutting back on infrastructure expenditure. The models were designed on the premise that if a SDI is considered to be classic infrastructure/ a natural monopoly then it should be possible to treat the financing of the SDI similar to that of any other infrastructure which is of national importance in terms of economical and social benefits. Thus, it should be possible to develop a SDI funding model using analogies and lessons learnt from the financing of other infrastructures such as highway networks, railroads, sewage and telecommunication networks to name a few. Based on the above concept and studies of general infrastructure financing and internet financing the following possible funding models for national level SDI implementation were developed:

1. Funding of a SDI through government financing. SDIs that fall into this category as mentioned previously should have strong arguments (e.g. Public Goods provider, Market Failure and Natural Monopoly) for total government funding (Giff, 2001). An example of a SDI created from centralized government funding is the Portuguese National SDI [Sistema Nacional de Informacao Geografica {SNIG}] (Nebert, 2001).

2. Government – Private Sector partnerships

3. The establishment of special banks or financial institutions to underwrite low interest loans for the investment in SDIs. These institutions can have a similar structure to Agriculture Credit Banks established in Europe to support the growth of agriculture or in North America The Business Development Bank of Canada. The Federal Geographic Data Committee (FGDC) is presently carrying out research in this direction (Urban Logic, 2000).

4. SDI funding can also be generated through the issuing of medium and long-term tax-free bonds specially targeted at large spatial data user (public and private) and spatial data software developers for example. The issuing of bonds however, is very dependent on market conditions and thus, research in present and future market conditions should be undertaken before applying this option.

5. The creation of the SDI as a service bureau or consortium. Shares in this new organization can then be issued on the stock exchange or through private subscriptions (Urban Logic, 2000);

6. Accessing of capital markets by the consortium for financial assistance such as revolving loans and other similar debt structures. Also large users of spatial data can be asked to pay a membership fee to the consortium (Urban Logic, 2000);

7. The application of incentives such as matching ratios to stimulate investment. Under this type of arrangement the central government would match (according to the specified ratio) the amount of funds invested into the SDI by other groups. This type of venture would encourage states to seek out investment for their SDIs so that they can access government funds (where appropriate). This type of model is well suited for Federal Government structures where individual states/provinces/territories are required to develop their own portion of a SDI, example Australia (Nebert, 2001).

8. Private Sector investment in the form of Build Own Operate Transfer (BOOT) scheme (Fraser et al, 2000).

9. In some cases depending on the implementation environment the models proposed above might fall short of raising the complete capital investment required for a SDI. A solution to this problem could be a combination of the models listed above. Combining the models would depend on government structure, financial markets and the political climate to name a few.

If the SDI is classified as an essential part of a nation's capital infrastructure producing goods for the public benefits, then the above models should be favorable alternatives for obtaining capital financing. These models can be collected together to create a SDI funding model pool (figure 2). From this pool suitable model(s) can be selected for SDI financing based on the implementation environment.

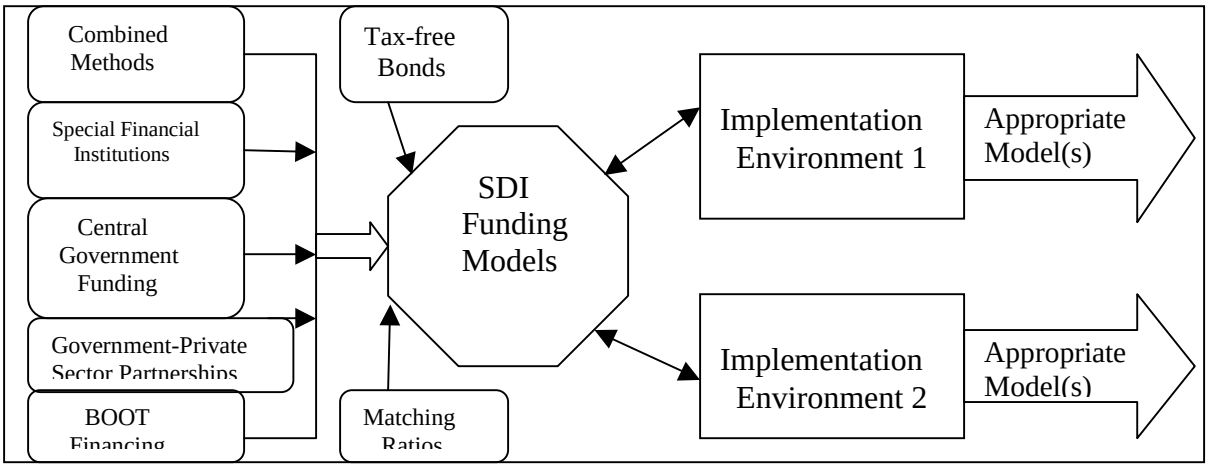

Figure 2: Funding Models Pool for National level SDIs

Funding Models for State/provincial Level SDI

The responsibility of implementing/organizing SDIs/general infrastructures at this level normally falls at the feet of the State/provincial government with central government playing the minority role (Harris, 2000). A SDI at this level may be viewed as a smaller version of a national SDI and thus, the significance of a provider of public goods will be down graded to a smaller scale. This implies that central/federal governments will be less willing to invest in state/provincial SDIs. Therefore the models for SDI implementation at this level will differ from that of the national level since, these

models were designed with the public goods theory and government as the main investor as key factors. Therefore, in order to fill the short fall in SDI financing at the state/provincial level resulting from central/federal government cut backs, the following innovative financing models were designed:

1. Funding from Central Government and Regional Government budgets. Matching ratio may apply here;
2. Funding through Regional Government budgets;
3. Regional Government – Private sector partnerships
4. Private sector investment based on expected returns on investment through value added products;
5. Project Financing and;
6. Matching ratio and tax incentives to potential partners.

In addition to models 1 to 6 above, a number of the models recommended for national level SDIs are also applicable here but at much smaller scale. Private sector contribution at this level is expected to be greater and should be encourage since, at this level the spatial information produced will be much more detailed and thus capable of offering higher economic returns.

Funding Models for Local Level SDI

A SDI at this level is only a component of the national and provincial level SDIs. Therefore, the funding structure should be less complex since the amount of funds required for implementation is less. Local level SDIs should involve more private sector participation since, as mention before the lower one goes on the SDI ladder the expected business activities to be generated should be greater. Funding Models that may be applicable to this level of SDI implementation are:

1. Private Sector investment both monetary and non-monetary
2. Local Government capital funding
3. Local Government –Private sector partnerships (e.g. with utility companies, GIS companies and the tourism sector)
4. Local Government – Public sector/ community organizations partnership (e.g. with environmental bodies, forestry, tourism and other community organizations)
5. Accessing special projects funding or aligning with central/state government financed special initiatives (e.g. the E-911 program in North America)
6. The issuing of tax incentives for the creation of GISs which would form components of the local SDI
7. Federal-State-local Government partnerships
8. Project Financing

A number of the components of a local level SDI will be derived from projects carried on by the private sector and or special government projects. Additional funding for these projects can also be obtained through the above models with more emphasis been placed on private sector contribution. Private sector contributions may be of the follow format: Data collection, Database management, Consultancy, Training, developing innovative business opportunities and the more familiar monetary investment.

Funding Models for Global and Regional Level SDI

The need for having spatial information available at this level is not a new concept. In fact the first attempt at having global spatial data available dated as far back as 1891with the proposal of the International Map of the World by Albrecht Penck (Thrower, 1996). Today, the need is even more recognized and more achievable due to technological advancements that fostered both better technical and institutional arrangements. This need is evident from the formation of a number of organizations (GSDI, EUROGI, CPIDEA and PCGIAP) all aimed at creating regional SDIs and ultimately a global SDI to provide access to accurate, consistent and complete world-wide spatial information.

The financing of a global SDI and regional SDIs are mainly the responsibility of all the nations of the world and the nations within the specific region. Therefore, funding models for SDI implementation at this level may take on the following formats:

1. Membership fees paid to the regional or global organization by the central governments of UN member nations (participating members). The level of contribution can be based on GNP.
2. Contribution from International Development Agencies (e.g. USAID,
3. Low interest loans from International Funding Agencies (e.g. World Bank and IDB) based on a business model for the SDI
4. Access funds designated to regional development for public benefits and or align with other regional bodies that are participating in work for public benefits. Working closely with these organizations will ensure that data is collected at the standard required by the global/regional body and thus, can be used to build component(s) of the GSDI/RSDI.

Customizing Funding Models for Emerging Nations

The models presented in the earlier sections were all designed based on the environment of the developed world. Therefore, the pertinent question to be asked here is whether or not these models are applicable to SDI implementation in emerging nations and nations in transition? Early research indicate that SDI implementation in emerging nations will differ from that of developed countries mainly because of the differences in the economic, political and socio-political climate of these countries. Therefore, if the proposed funding models are to be used to finance SDI implementation in emerging nations / nations in transition then they must be adjusted for the above mention factors.

The models presented so far relied heavily on the assumption that the economies and government structures of the implementation environments are vibrant and stable. However, this is not the case in most emerging nations as theses nations tend to have very weak if not stagnant economies with unstable governments. Therefore, it is hardly likely that the struggling economies of emerging nations will be capable of financially sustaining the implementation of a SDI through government funding.

Since, emerging nations cannot afford to support SDI implementation from governments' budget and their economies are not vibrant enough to motivate a private

sector or a private sector/government funded implementation then funding must be sought externally. This is normally achieved through donor agencies. This implies that the activities of donor agencies will play an essential part in the designing of funding models for emerging nations.

Supporting infrastructure development in emerging nations is not a new concept to donor agencies (World Bank, 1996). However, what is new is the concept of a SDI, which must be sold to these donor agencies if funding is to be secured. Receiving donations from these agencies is not the total answer to a SDI program manager's prayer since these donations normally have conditions attached. For example, there is normally a limited life span placed on the project plus the restriction of limited funds (Nebert, 2001). Funding models that might be suitable for sustaining SDI implementation (national to local) in emerging nations are:

1. A Government and Donor Agencies partnership

2. The creation of a government, Donor Agencies and private sector partnership

3. The creation of a donor pool. That is, a partnership amongst different donor agencies with each agency responsible for different aspects of the SDI (Nebert, 2001). This donor pool should be organized in such a manner that it will ensure there is sufficient funds to sustain the SDI until it becomes self-sufficient or other methods of funding are secured.

4. Matching ratios with the Private Sector (local and international). Tax incentives can be used to support cash or as a substitute for the scarce resources (DeBoer et al, 1993).

5. Non-monetary Private Sector Contributions

6. The development of a business plan for the SDI. A good business plan will facilitate a SDI program manager in the selling of the concept of a SDI to donor agencies and key decision-makers within governments (CIE, 2000).

7. The establishment of special banks or financial institutions to underwrite low interest loans for the investment in SDIs. This can be done in conjunction with international lending agencies.

8. Project Financing

9. Tied Aid/Financing – Funds are tied to purchases from donor country(s)

The development of a business plan is an important aspect of financing a SDI. It will be an absolute necessity for the application of models 7-9 and along with the public good argument a good seller of the benefits of a SDI to governments, donor agencies and financial institutions.

The models proposed for implementation in emerging nations are a result of early research and still requires more in-depth research to design more and better models more suitable to the environments of these nations. Further research may take the form of an in-depth case study of one or emerging nation and is the methodology currently under review by the researchers.

Conclusion

The paper discussed the concept of having SDIs at different levels of the information society and the need for having funding models for financing the implementation and maintenance of these SDIs. The latter sections of the paper presented models suitable for financing the different levels of a SDI (as proposed by Rajabifard, 2002) in both developed and emerging nations.

The models presented were designed based on the key factors that influence financing at each level within the implementation environment. Models for SDIs at the Global to the National level were designed with an emphasis on sourcing government related/managed funds and private sector investment to a lesser extent. This was justified since, SDIs at these levels can be treated as infrastructures providing goods and services for the public benefits. Resulting from the formation of these types of infrastructures is market failure, which requires government intervention to correct and ensure the provision of public goods and services. SDIs at the lower levels targeted more private sector investments since it is easier to emphasize the economic feasibility (possible through a business model) for these SDIs thus attracting more private sector money. The final category of models presented was designed based on the environment of emerging nations. Preliminary modeling of the environment of these nations revealed that they were not capable of generating sufficient funds from both government and local capital markets for SDI implementation and thus, the emphasis on international capital markets and funding agencies.

The models presented here is not an exhaustive list of all the possible models for SDI implementation as the research is still ongoing especially in the area of emerging nations. However, it is the authors' hope that in presenting the models designed so far additional interest will be generated in this aspect of SDI implementation resulting in adequate capital financing models for the next generations of SDIs.

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